Dec. 24, 1935. W. F. COTTER ET AL 2,025,093

INDUCTANCE DEVICE

Filed Oct. 26, 1932

Fig. 1.

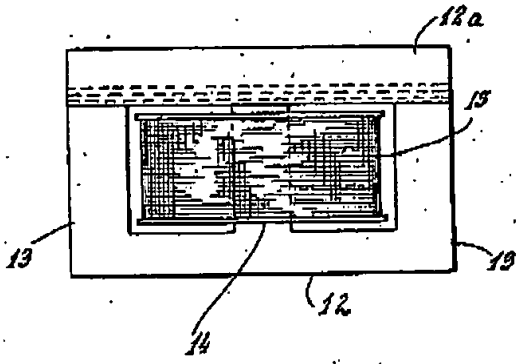


Fig. 2.

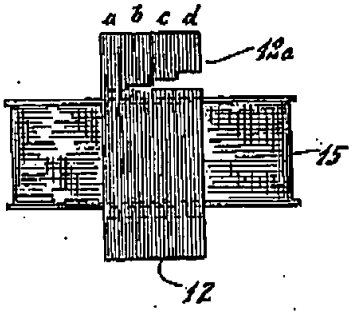


Fig. 3.

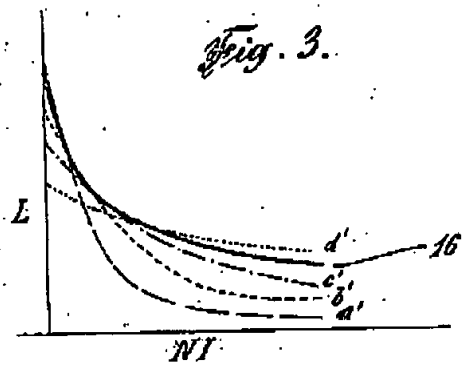
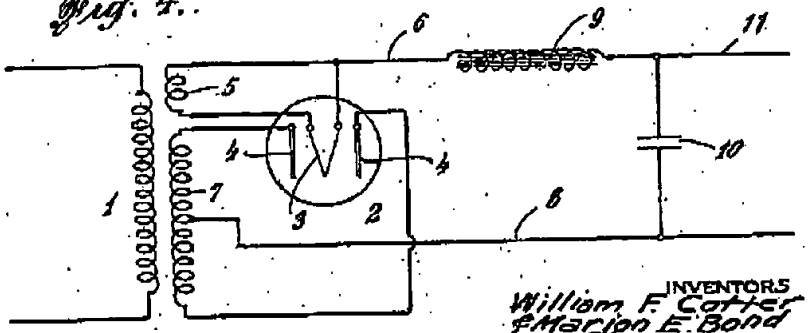


Fig. 4.



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2,025,093

INDUCTANCE DEVICE

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3 Claims. (Cl. 175—363)

This invention relates to improvements in inductance devices, and more particularly when employed in the low pass filter network of a radio power supply unit, as a filter reactor.

The object of this invention is to provide a reactor which automatically assumes a maximum value of apparent inductance over a wide range of direct current through the reactor.

Another object of this invention is to provide an inductance whose value remains more nearly constant under a direct current flow of wide variation.

Another object is to enlarge the direct current carrying capacity or rating of an inductance without having the value thereof drop to a point so low that it becomes useless as a filter element in radio power systems.

Still a further object is to provide an inductance having rigid elements but with a core so designed as to present the effect of having a variable air gap, which changes with the degree of core saturation.

Other objects and improvements will become apparent when the following description is read in view of the drawing and diagrams in which:

Fig. 1 shows a side elevation of an inductance device according to our invention; Fig. 2 is a side view of same; Fig. 3 is a diagram showing the variation of effective A. C. inductance value with the load current; and Fig. 4 presents an outline of one method of using our invention.

The same numerals identify the same parts throughout.

It is well known in the art that reactors may be designed for efficient operation at specified values of direct current in the winding. For example, an iron core reactor may be designed with an airgap which will give a maximum value of apparent inductance at one particular value of direct current. However, for lower values of direct current the apparent inductance is not as high as it would be if the airgap were made smaller. Also for higher values of direct current the apparent inductance is not as high as it would be if the airgap were made greater.

In this design of radio power supply systems the object desired is to attain stable output voltage under fluctuating current drain and at the same time maintain the values of the filter elements, or the LC ratio relatively constant, in order to remove the hum producing fluctuations of the rectifier output. There is no difficulty in designing an effective filter section containing the inductance and capacitance necessary to make it effective at the hum frequency provided the current drain from the system is constant. In certain radio practice the current drain is not constant, for the tubes draw currents in proportion to the constantly fluctuating volume level of the program. This causes a changing direct current through the windings of the inductance or filter choke, and results in a varying degree of magnetization in the core thereof. Under severe current conditions the core becomes saturated, the effective reactance of the choke to the A. C. component of the rectifier output becomes very low, and a poor filtering action results. The effective A. C. inductance of the choke changes with the degree of magnetic saturation and the net result, when combined with a fixed amount of capacity, is a circuit in which the element relation and therefore the filtering effectiveness varies widely.

In low pass filters as used in radio power supply systems, values of capacity and inductance are chosen which will have a cut-off at some frequency below that of hum. The product of these two factors should remain constant in order to retain any given cut-off frequency. It is obvious, therefore, that if the value of inductance drops while the capacity stays constant, the cut-off frequency will be raised and a larger percentage of hum component will pass through the filter. We propose to remedy this state by providing an inductance or choke whose effective A. C. inductance remains more constant under a wide variation in current flow, and whose general effectiveness does not drop severely when subjected to heavy current.

To explain the function and utility of the invention reference is first made to Fig. 4 wherein 1 indicates the primary of an alternating current transformer and 2 a vacuum tube rectifier having a cathode 3 and a pair of anodes 4. The cathode 3 is heated by current from a coil 5 inductively related to the coil 1 and one pole of the cathode is connected to a lead 6. The anodes 4 are each united to a separate extremity of a secondary coil 7 inductively related to the coil 1 and the numeral 8 indicates another lead united to the mid-point of the coil 7. In the line of the conductors 6 and 11 is an inductance 9 according to our invention and the two leads 11 and 8 are bridged by a condenser 10.

To obtain proper filtering and voltage regulation the inductance is made as shown in Figs. 1 and 2, wherein the numerals 12 and 12a indicate the two sides of a magnetic frame having ends 13 and a transversely extending portion 14 in the middle which serves as a core for the turns of a

coil 15. The side 12, ends 13 and middle portion 14 are made in one piece laminations in the form of an E, while the side 12a which bridges the faces of the ends 13 and middle portion 14 is separately constructed and is of variable cross section as indicated in Fig. 2. For example, the side 12a will be of varying width and comprises portions a, b, c and d, the portion a making contact with the surface of the ends 13 and middle portion 14, while the portions or sections b, c and d, which are rigid with section a, are separated from the terminal face of the ends 13 and portion 14 by air gaps of progressively greater extent. The entire magnetic circuit of the coil 15 can, of course, be laminated and all of the parts will be rigidly secured to one another.

The effect of a magnetic circuit, such as shown in Figs. 1 and 2, is illustrated in Fig. 3, wherein the curves a', b', c' and d' indicate the relation between the product of the current and number of turns of the coil to the inductance L for each of the sections a, b, c and d. The values of the effective A. C. inductance L are plotted as ordinates and the values of the product of the number of turns and current are plotted as abscissas so that it will be seen that the inductance drops as the ampere turns increase. The line 16 represents the combined or resultant effect.

When a small D. C. current is passed through the winding 15, the magnetic flux is substantially confined to the core section a. When the current is increased, the flux is shifted toward the stepped sections b, c and d according to the proportionate current intensity. This action gives the effect of altering the airgap and the reluctance of the magnetic circuit to suit the needs of the momentary current intensity. Thus the tolerance of the choke to what would ordinarily be overload currents is materially increased, likewise the drop in A. C. inductance value usually associated therewith is substantially reduced, and the inductance is maintained automatically in proper relation to the D. C. current flow to produce efficient regulation.

This invention is highly satisfactory in practice, is inexpensive to build, and is of simple construction. The performance and characteristics are certain, and all likelihood of functional derangement is avoided.

While we have shown and described our invention as applied to a particular system and as embodying the various devices indicated, changes and modifications therein will be obvious to those skilled in the art and our object is therefore to cover all such changes and modifications as fall within the true spirit and scope of our invention.

What we claim is:

1. In a radio power supply device, the combination of a rectifier and a filter circuit connected to the output of said rectifier, said filter circuit including a series connected inductance and a condenser connected across said circuit at the output side of said inductance, said inductance comprising a winding around a laminated core, said core being formed with paralleled stepped airgaps therein of successively differing lengths.

2. In a radio power supply device, the combination of a rectifier and a filter circuit connected to the output of said rectifier, said filter circuit including a series, connected inductance and a condenser connected across said circuit at the output side of said inductance, said inductance comprising a winding around a laminated core, one side of said core being formed with paralleled stepped airgaps therein of successively increasing extent.

3. In a radio power supply device, the combination of a rectifier and a filter circuit connected to the output of said rectifier, said filter circuit including a series, connected inductance and a condenser connected across said circuit at the output side of said inductance, said inductance comprising a winding around a laminated core, said core having paralleled stepped airgaps of successively increasing extent formed in a horizontal side thereof.

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